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Indian Standard

RECOMMENDED PRACTICE FOR CLEANING METALS PRIOR TO ELECTROPLATING

(First Revision)

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Indian Standard

RECOMMENDED PRACTICE FOR CLEANING METALS PRIOR TO ELECTROPLATING

(*First Revision*)

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Indian Standard

RECOMMENDED PRACTICE FOR CLEANING METALS PRIOR TO ELECTROPLATING

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 10 June 1980, after the draft finalized by the Metallic finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was earlier published in 1965. In this revision, detailed procedures on precleaning and other factors which affect the good adhesion of electro deposited metals, have been explained. These procedures are broadly applicable, although particular substrates may require certain specific cleaning procedures. Methods of removal of heat-treated mill scale are not included in this standard.

0.3 While preparing the standard, assistance has been derived from 1979 Annual Book of ASTM standards Part 9.

1. SCOPE

1.1 This standard describes the procedure for cleaning metal surfaces prior to electroplating to obtain good adhesion of elctrodeposited metals.

2. FACTORS IN SELECTION OF CLEANING PROCESS

2.0 The cleaning process should be carefully selected to give maximum efficiency and economy taking into account the availability of chemicals and equipment.

2.1 Nature of Soil — Some of the soils commonly encountered in electroplating are:

a) solid buffing compounds containing waxes, fatty acids and abrasives;

b) liquid buffing compounds;

c) drawing stamping compounds including those containing fillers (pigments);
d) machining oils;
e) finger prints;
f) dry dirt from storage or dry pickling smut formed during derusting by pickling;
g) rust or oxide scales, especially admixed with oil, including heat-trated scales after oil quenching;
h) smut resulting from annealing parts without precleaning between drawing operations;
j) smut resulting from improper vapour degreasing of heavily buffed work;
k) rust preventive slushing oils or greases;
m) plater's stop off residues;
n) phosphate coating with or without lubricant; and
p) heat-treating salts, with or without quenching oils.

2.1.1 The following points should be considered in order to avoid accumulation of different types of soils mentioned above, on the substrates:

a) Avoid overbuffing;
b) Substitute liquids with solid buffing compound;
c) Avoid drawing compounds with polymerizing oils or white lead pigment;
d) Avoid additives for lubricating and sulphurized cutting oils as they are difficult to remove. Soluble oils should be used in place of sulphurized cutting oils if operations permit. Lower viscosity machining and rust preventive oils are more easily removed;
e) Avoid prolonged storage or drying of emulsion drawing compound after metal working;
f) Clean by a hot water flush before storage;
g) Avoid contaminating significant surfaces while using stop-off materials;
h) Use clean gloves after buffing or polishing to avoid fingerprints on the work;
j) Use covers over stored work; and
k) Perform cleaning operations as soon as possible after metal forming, polishing, buffing, etc, as the soils are more easily removed when fresh.

2.2 Basis Metal

2.2.1 The composition, chemical and physical properties of the basis metal shall be considered, when selecting the cleaning process. The chemical activity of the metal is an important factor in cleaning. Steel parts are not attacked by strong alkaline solutions, whereas aluminium and zinc are sensitive to pitting attack. Zinc and brass are readily tarnished. Die-castings have surfaces that require special care because of sensitivity to attack by cleaning solutions.

2.2.2 Part design, size and softness of metal are some determining factors in selecting rack design and handling methods.

2.3 Cleaner

2.3.1 A cleaner may do an excellent job of soil removal, but if it attacks or even slightly etches the surface, it is undesirable. Certain cleaners may be very effective for one group of soils, yet may be poor for other soils. This is true of electrocleaners as well as soak or spray cleaners. The following factors influence the selection of the type and operation of cleaners:

a) Type and condition of the metal;
b) Soil;
c) Quality of water;
d) Time, agitation and availability of heating;
e) Rinsing technique;
f) Jigging technique;
g) Plating process and finish desired;
h) Availability of chemicals and equipment; and
j) Operating personnel.

2.3.2 Cleaners have a certain life. The effective life of a cleaning bath shall be estimated and baths discarded when exhausted. It should be replaced a few days before the deterioration of the bath starts. Pure soft water or demineralised water should be used in preparing cleaners.

2.4 Rinses — Water hardness, acidity or alkalinity, agitation, flaws and impurities are important factors in rinsing. Soft and clean water should be used. Boiler condensate may be used but demineralized water is preferable. Solid content of water should not be high (*see* Note 1). Impurities derived from processing cannot be ignored; that is rinse water shall be changed frequently or overflowed continuously (*see* Note 2).

NOTE 1 — Boiler waters which contain cationic corrosion inhibitors may be quite detrimental to the plating process.

NOTE 2 — Floating oil on water can cause poor adhesion.

3. CLEANING PROCEDURES

3.0 The cleaning procedure may be divided into the following main stages:

a) Precleaning with a solvent to remove the bulk of the soil;
b) Intermediate (alkaline) cleaning; and
c) Final electrocleaning to remove residual trace solids and adherent impurities and smuts from the components.

3.1 Precleaning — Removal of large excess of soil, especially stamping and buffing compound or grease, is useful in reducing the viscosity of waxes and heavy oils to enable final cleaning easier. The following types of precleaning process may be used.

3.1.1 *Cold Solvent* — The chlorinated solvent (trichloroethylene; perchloroethylene; 1, 1, 1-trichloroethane; etc) are very effective for many soils but not as effective in removing soap based or other solvent insoluble soils. Cold cleaning with solvent should be followed by additional cleaning such as alkaline cleaning to remove slight oil residues.

3.1.2 *Vapour Degreasing* — Trichloroethylene and to a lesser extent the other chlorinated solvents are used for vapour degreasing. The work is usually sprayed with clean solvent or given a thorough immersion in boiling or warm solvent for mechanical removal of tenacious soil or solids followed by immersion in cold solvents to cool the parts. The work is then exposed to clean solvent vapours thereby removing any last traces of oil and grease and this helps in drying the parts.

3.1.2.1 This method simplifies cleaning of parts made of ferrous and non-ferrous metals such as steel, light metal alloys, other non-ferrous metals, nickel, etc, because it cleans by solvent action instead of a chemical action and there is no danger of overcleaning or under-cleaning from any difference in chemical activity of the metals present. Parts containing recesses, blind holes, perforations, crevices and welded seams are cleaned because of the rapid penetrating action of the solvent and solvent vapours.

3.1.2.2 Vapour degreasing is effective on solvent-soluble soils and chemically active lubricants. Insoluble soils, such as buffing, grits, metal chips and dust, etc, are flushed away as the soluble soils (greases and oils) dissolve in the solvent. It is not effective on metallic salts, scale, carbon deposit, many inorganic soldering or welding fluxes and fingerprints.

3.1.3 *Emulsion Cleaners* — Oils and high boiling hydrocarbons such as kerosene have the ability to dissolve most greases, particularly at high temperatures. The addition of emulsifiers, soaps and wetting agents enhances the penetrating power of the organic solvent and permits removal of the latter and associated soil by high power cleaning. Further, intimate contact of the metal surface with the aqueous phase permits removal of materials not soluble in the hydrocarbon phase.

3.1.4 *Safety Precautions*

3.1.4.1 The use of chlorinated solvents and emulsions of diphase cleaners requires special attention to safety hazards. Trichloroethylene and perchloroethylene are non-flammable under the conditions of vapour degreasing process and up to 100 ppm of either is tolerable in the working atmosphere for normal 8 hour working day. With proper equipment design and operation, solvent vapours in the working area are easily maintained well below recommended safe limits. Degreaser tanks should perferably be cleaned and maintained outside the tank. Entry into the tank should be made only after all solvent and vapours have been removed, in the presence of an observer on the outside. For cold solvent operations, adequate ventilation shall be provided in the work area.

3.1.4.2 Since soils accumulate in solvents, the solvents shall be discarded or purified by distillation. In vapour degreasing equipment, the solvent is recovered by distillation and the soil discarded. The use of automatic auxilliary stills in conjunction with the degreaser allows continuous cleaning operation and solvent recovery.

3.1.4.3 Emulsifiable solvents shall be discarded occasionally, although frequently the most of the soil is flushed off in the rinse. Emulsion cleaners represent a particular problem of bath contamination because of the lack of adequate analytical controls to determine bath life. Because emulsion cleaners yield a water-shedding surface, the effect on water-break due to accumulated oils is difficult to differentiate from that due to the solvent. Because of the low cost of diluted emulsion cleaners, it is economical to discard these baths at frequent intervals. Soap-base emulsion cleaners may cause difficulties where acidic soils are introduced; here mixed alkalies and emulsion cleaners may also require water conditioning in hard-water areas to avoid precipitation of hard-water soaps. Good housekeeping is desirable to avoid bacterial contamination of emulsion cleaners.

3.2 Intermediate (Alkaline) Cleaning — Intermediate alkaline cleaning removes solvent residues and residual soil which has been softened or conditioned by precleaning. Spray or soak alkaline cleaning also may be used as a precleaning stage followed by additional alkaline cleaning if the soil and metal lend themselves to this treatment. This is not so for metals that are sensitive to alkaline cleaning, such as zinc, since the time in the alkaline cleaner should be minimal.

3.2.1 *Types*

3.2.1.1 Soak alkaline cleaning is carried out at 30 to 120 g/l of alkaline cleaner at temperatures of 80°C to boiling, for periods of 3 to 15 minutes. The cleaners usually contain surface-active, soaplike materials which foam if agitated vigorously.

3.2.1.2 Spray alkaline cleaning is usually carried out at 4 to 15 g/l at temperature of 50 to 80°C for 1 to 3 minutes with spray pressures of 69 to 345 kPa. Foaming may be a problem, unless the cleaner is properly designed.

3.2.1.3 Foam is also a major problem because of accumulation of soaps in the cleaner from the action of the alkali on some organic soils and drag-in of wetters from precleaners. For this reason, it is desirable to (a) use low concentrations of cleaner, for example, 4 g/l; and (b) discard the solution often, even though cleaning is adequate. For the same reason, it is sometimes necessary to operate at lower pressures even though higher pressures give better cleaning.

3.2.1.4 Barrel alkaline cleaning is usually carried out at 7·5 to 45 g/l. Temperatures are usually lower than for soak cleaning because of mechanical factors. Although agitation is better than in some cleaning, control is frequently not as good.

3.3 Factors Influencing Good Alkaline Cleaning

3.3.1 *Concentration* — The optimum concentration of the cleaning solution should be determined by actual tests because many factors are involved.

3.3.2 *Temperature* — Best results are obtained near the boiling point if other conditions permit. The high temperature reduces the viscosity of the soil. A rolling soil provides agitation.

3.3.3 *Time* — Alkaline cleaners, operating by the mechanism of lifting the oil film, require a reasonable time to permit the surface active materials to act on the surface. This time is shortened if agitation is vigorous, temperatures high, and concentration high. Ageing of solution and contamination retard cleaning.

3.3.4 *Agitation*

3.3.4.1 *Spray cleaning* — As in emulsion cleaning, much of the effectiveness of spray cleaners in removal of solids is due to the mechanical action of the solution sprayed on the surface. Hence, every effort should be made to obtain efficient impingement at high pressure without pushing the work out of the spray area (or off the racks).

Foaming after soap accumulation also limits spray pressure. The action of spray alkaline cleaners depends on detergency as well as mechanical action; the proper materials and conditions should be used. Spray nozzles should not be allowed to clog with solids and vestibules should be provided at each stage of the machine to avoid contamination by overspray. Agitation is very good in spray cleaning (if the sprays hit the solid surfaces directly).

3.3.4.2 *Soak cleaning* — Suggested methods of agitation in soak cleaning are as follows:

a) Complete withdrawal and re-immersion, especially at about half the total time allotted in the cleaner;

b) Pumping the solution over the work with proper intake and adequate pressure;

c) Rapid motion of the work in the cleaner;

d) Maintenance of a rolling boil;

e) Use of an air line or a mixer; and

f) Use of an overflow weir assists in separating unemulsified oils, grease, and other solids.

NOTE — Ultrasonic waves cleaning may be effectively used for effective cleaning of small and delicate jobs.

3.3.5 *Age and Degree of Contamination* — A long bath life is desirable, not only for economy but also to avoid the necessity for constant supervision. Alkaline cleaners vary in this respect; much depends on the amount of soil present on the work being cleaned. Care shall be taken to avoid redeposition of the soil as parts exit from the cleaner. Cleaners should be discarded periodically because of accumulation of debris, and the like. Surface oil should be skimmed frequently, preferably by overflowing into a properly designed skim rough. The cleaner should be buffered to have a high tolerance for acidic soils. Tolerance for soaps, formed by reaction with the soils, can be designed into the cleaner when necessary.

3.3.6 *Rinsing* — Double rinses are desirable to reduce the concentration of cleaner in the rinse. A first hot rinse gives more efficient cleaner removal, while a second cold rinse reduces the tendency to rusting and tarnishing during transfer to the next stage. If rinsing is inadequate, the components of the cleaner may require some sacrifice in cleaning properties. Rinse tanks should have adequate overflow rate, skimming troughs of good design, and proper positioning of the intake water line.

3.3.6.1 Agitation of work in the rinse tank is desirable. Water shall also flow through hot rinses; although a reduced rate is often desired for economy. Spray rinsing is very effective, especially if coupled with soak rinsing by having a spray of clean water hit the work as it exists from the rinse tank. Drying of the cleaner on the work before rinsing should be avoided by having fog nozzles after cleaning tanks, if necessary, or by decreasing transfer time or operating temperatures. With some cleaners, adequate rinsing is difficult to obtain after the cleaner has dried on the work.

3.3.7 *Selection of the Cleaner* — Important factors to be considered are as follows.

3.3.7.1 *Soil* — If the soil is rich in soaps, the cleaner should be lean in this respect and should have built-in high soap tolerance. Because of the specific action of the individual cleaners on certain soils, this is a prime factor in cleaner selection.

3.3.7.2 *Metal* — Special cleaners are designed to avoid harmful effects on zinc, aluminium, and brasses. Iron, steel, magnesium and copper have better tolerance to alkaline cleaners.

3.3.7.3 *Water* — Use of hard water for cleaners necessitates addition of water softeners, such as sequestering and chelating agents, largely to prevent difficulties during rinsing.

3.3.7.4 *Method of application* — There is no universal cleaner that can be efficiently applied by all methods of cleaning. The cleaner should be formulated for its method of application. Cooperation of purchaser with vendor in permitting study of equipment, and availability of heating facilities will minimize problems such as incomplete cleaning, excessive foaming, and dry down of cleaning solution before rinsing.

3.4 Degree of Cleanliness Required — The degree of cleanliness required for the next operation should be determined by the purchaser and explained to the vender. If parts are to be held over between operations, a light oil or alkaline protective film may be advantageous to prevent rusting. Parts going immediately to electroplating should be free from any objectionable films that might prevent adhesion of electrodeposits.

3.4.1 *Unit Cost* — Many factors enter into the cost of a cleaning operation. Among them are: yearly cost of space occupied by the equipment, capital costs and amortization of equipment, utilities (water, heat, power, etc), maintenance by laboratory control, make-up, additions, and disposal of spent solutions, labour, cost of cleaning compounds, and cost of reprocessing rejects. To obtain true costs, all these factors shall be included.

3.4.2 *Safety* — Consideration shall be given to the safety of operators and equipment and parts being cleaned (*see* **3.1.4** and **5**).

3.4.3 *Disposal of Spent Solutions and Rinse Waters* — Increasing attention to reduction of stream pollution throughout the country means that this factor will become a more decisive one in selection of cleaning materials. Examples of materials that may come under such regulations are: chromates, cyanides, nonbiodegradable detergents, phenolics, spent solvent emulsions, and phosphates. Refer to IS : 2488 (Part I)-1966, IS : 2488 (Part II)-1968 and IS : 2488 (Part III)-1968*.

4. FORMULATIONS OF ALKALINE CLEANERS

4.1 General — Actual compositions of cleaning materials for various metals, soils, methods of application, degree of cleanliness required, and other specific conditions are beyond the scope of this standard. The fact that individual suppliers of proprietary cleaning materials have hundreds of standard products available, indicates the complexity of this field. In like manner, the recommendations for their application vary widely. Some requirements for formulations of cleaning materials are listed below.

4.2 Soak Cleaners

4.2.1 Ability to saponify animal and vegetable oils, if conditions such as paint stripping require it on steel parts. Otherwise, this requirement may be undesirable where sensitive metals are involved, since attack on the metal may occur thereby.

4.2.2 Wetting and emulsifying action supplied by soaps or synthetic surface agents to wet oily and greasy deposits and, with agitation, suspend the deposits in an emulsified state until rinsing is accomplished.

4.2.3 Deflocculating action or colloidal properties to attract solid particle soils and suspend them in a free rinsing condition, so that redeposition of the soil is prevented.

4.2.4 Water-softening ability to sequester or chelate calcium and magnesium ions by combining with them to form water soluble nonionic complexes.

NOTE — Use of polyphosphate-type sequestering agents is limited to temperatures below 80°C, because decomposition into orthophosphates occurs above this temperature. Organic chelating agents are stable above 100°C. Chelating agents also have the ability to form water-soluble complexes with di- and trivalent insoluble metallic salts, such as iron oxides. Thus, specially compounded soak cleaners can remove rust, heat scale, and iron or zinc phosphate deposits as well as oily or other soils.

4.2.5 Buffering action to maintain the optimum *p*H range, despite introduction of acidic or alkaline soils.

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*Methods of sampling and test for industrial effluents, Part I to III.

4.2.6 Proper inhibitors for prevention of attack of sensitive metals.

4.3 Spray Cleaners

4.3.1 The short duration of spray washing operations generally precludes necessity for inclusion of saponifying action.

4.3.2 Wetting and emulsifying action is incorporated in this type of cleaner, but to a much lesser degree than in soak cleaners, to prevent excessive foaming. Special low-foaming surface-active agents are generally used. Otherwise, antifoaming ingredients are a part of the formulations.

4.3.3 Deflocculating action, or use of colloidal materials, is beneficial in suspending solid particle soils. However, unless properly compounded, they may cause excessive foaming.

4.3.4 Water softening to prevent formation of insoluble calcium scales on heating coils, spray nozzles, etc, is a necessary requirement of these cleaners.

4.3.5 Because of the large area of work going through spray washing machines and the lower concentrations of cleaner used, buffering action is an essential part of a spray cleaner, to maintain effective life.

4.3.6 Depending on the type of metal parts being cleaned, an inhibitor may or may not be required.

5. PRECAUTIONS

5.1 Some alkaline cleaners generate considerable heat when dissolved in water. Rate of solution, however, is frequently very slow in cold water. It is most advantageous to have the water at a temperature of about 50°C while the cleaner is carefully sprinkled in small quantities over the surface of the tank, as with a shovel. Others prefer the safer but slower process of adding the cleaner directly to the tank of water at room temperature with provision for agitation to avoid caking. A caked cleaner dissolves slowly. If alkali gets on the skin, it should be washed profusely with water and medical attention received promptly.

6. FINAL ELECTROCLEANING

6.1 The objectives of metal cleaning before electroplating have been summarized as follows:

> In electrodeposition a surface is required which will receive a smooth, adherent metal deposit, but this is not necessarily an absolutely clean surface. In general, an acceptable surface is one on which objectionable surface films have been replaced by films more suitable and acceptable for electroplating.

6.2 Assuming that the metal parts have been precleaned by methods described above, the " objectionable surface films " are precleaner residues, minor amounts of soils such as oils and solid particles not completely removed by previous cleaning treatments. Thus, the final electrocleaning process is insurance that only films remain that are " more suitable and acceptable " for the electroplating operations.

7. TYPES OF ELECTROCLEANING

7.1 Electrocleaning is soak cleaning with agitation provided by the upward movement of bubbles of hydrogen or oxygen formed by the electrolytic decomposition of water in the solution. Because of this electrolytic action special types of cleaners are required.

7.2 Cathodic Cleaning — Parts negatively charged in the electrocleaner tank are cathodically or direct current cleaned. Hydrogen gas is evolved on the surface. Positively charged ions and colloids are attracted to the cathode.

7.2.1 Cathodic cleaning provided greater agitation because two volumes of hydrogen are evolved on the surface, as compared with one volume of oxygen at the anode. In cathodic cleaning, little or no tarnish or attack of nonferrous metal occurs.

7.2.2 Cathodic cleaning attracts positively charged metallic ions, soaps, and other colloidal materials in the solution causing them to ' plate out ' as loose smuts on parts being cleaned. Since hydrogen is evolved on the parts it may penetrate and become occluded in hardened steel parts, causing embrittlement. Cathodic electrocleaning solutions are more sensitive to chromic acid contamination than anodic electrocleaning solutions.

7.3 Anodic Cleaning — Parts positively charged in the electrocleaner solution are anodically or reverse current cleaned. Oxygen gas is evolved on the surface. Negatively charged ions and colloids are attracted to the parts.

7.3.1 A higher degree of cleanliness is obtained owing to the " deplating " action resulting from the positively charged surface repelling positively charged metallic ions, soils, and smuts. Oxygen gas does not enter metals as hydrogen does. Anodic electrocleaning solutions have much more tolerance for chromic acid contamination.

7.3.2 Less agitation occurs at the anode surface because only one volume of oxygen gas is evolved from the electrolytic decomposition.

NOTE 1 — Nonferrous metals are tarnished or attacked if anodic cleaning is prolonged in an uninhibited electrocleaning solution. However, this action may be beneficial as discussed in **7.3.1**. Alloys of lead, nickel, or silver and nickel, and silver plated surfaces should not be anodically cleaned. Lead alloys are rapidly attacked and nickel and silver surface become passivated, requiring special activating treatments for subsequent electrodeposition.

8. CRITERIA OF CLEANLINESS

8.1 Water-Break Test — This involves a visual observation after a final rinse in clear cool water. A continuous sheet of water on the surface formed after a drainage time of 30 seconds indicates a clean surface. Sometime the test may be a little misleading as it is difficult to rinse off all the alkali or wetting agents. In such cases, give a dip in clean dilute acid (for example, 1 to 2 percent sulphuric acid) after water rinse and re-examine after another good water rinse.

8.2 For routine testing, part entering the plating bath should be free from smuts; and when wiped with a clean white cloth, there should be no darkening of the cloth.

9. DETECTING TROUBLE IN SPECIFIC CLEANING OPERATIONS

9.1 Soak or Hot Still-Tank Cleaning

9.1.1 *Heating* — Check the temperature. There should be sufficient heating capacity to keep the solution at the proper temperature during full production. If steam coils are used, check for leaks diluting the solution. Check that the heating element is not insulated from the solution by scale or sludge. Check the operation of the thermostat.

9.1.2 *Agitation Shield and Overflow Dam* — The solution should be properly agitated by bringing fresh cleaner solution continuously to the work. The soils should be skimmed from the solution surface over the dam.

9.1.3 *Contamination* — Heavier production can cause undue soil loading of the cleaner. Check the age of the cleaner. Investigate introduction of any new soils that might cause the cleaner to become exhausted prematurely.

9.2 Spray Washing Machines

9.2.1 *Heating* — Check thermostats, scale on heating coils or tubes, and solution temperature. Descale the machine, if necessary, with inhibited hydrochloric acid or a proprietary descaling chemical to improve heating efficiency.

9.2.2 *Spray Risers* — There should be enough spray risers, properly positioned and directed to contact all surfaces. The nozzles should be periodically cleaned.

9.2.3 *Pumps and Lines* — Check on the return side to be sure that no air is being sucked into the system causing excessive foaming.

9.2.4 *Baffles* — The cleaning and rinsing stages shall be properly baffled to prevent one from contaminating or diluting the other.

9.2.5 *Contamination* — Excessively dirty cleaning solutions cannot be expected to function properly. Grease overflow dams shall function properly. Production shall not be excessive before a new cleaner is made up.

9.3 Electrocleaners

9.3.1 *Current Density* — Too high a current density when cleaning metals anodically may etch a buffed surface or cause excessive tarnishing. Too high a current density when cleaning cathodically will cause plating out of dissolved metals and some colloids as a smut. Too low a current density (cathodic or anodic) can be the cause of poor cleaning. Check the current with tong ammeters if available and calculate current density. Good steel electrocleaning requires a minimum of 500 A/m^2; 800 to 1 000 A/m^2 is better. Brass and zinc die castings and nickel plate normally are cleaned at 200 to 400 A/m^2.

9.3.2 *Bus Bars* — Be sure that the bus bars are of ample size to carry the current required for a work load (normally 158 A/cm^2 cross section of copper bar). Be sure that the bus bars are clean to ensure good contact.

9.3.3 *Polarity* — Be sure that the polarity is proper for the job. Cathodic cleaning should seldom be used as a final electrocleaning step because of the danger of plating out dissolved metals. There are exceptions to this rule, as in electrocleaning lead, magnesium, nickel, silver and some stainless steels. If doubt exists as to polarity, check with a voltmeter or trace back the conductors to the current source.

9.3.4 *Insulation* — Be sure that the tank is insulated from the floor, and that the work, electrode rods, and electrodes are insulated from the tank. Insulated joints on steam, drain, and water lines should be provided.

9.4 Rinses — Rinses should be kept clean and overflowing. Some cleaners require warm rinses for maximum efficiency. The cleaner supplier's instructions should be followed. It is poor practice to use a common rinse tank for several purposes, such as soak cleaning, electrocleaning and acid dip. Air agitation in rinses is beneficial.

10. FAILURES ATTRIBUTABLE TO CLEANING

10.1 Blisters, Peeling or Poor Adhesion — These defects may be caused by improper polarity in electrocleaner, overcleaning (current densiry too high or cleaning time too long), no current in the electrocleaner, and oil and grease not completely removed. In certain circumstances, a specially with materials used in the electronic industry, such plating defects may arise from other factors as well.

10.2 Pitting — Pitting may be due to oil and grease not being completely removed. If pitting is general and on all parts, the trouble is probably in the plating tanks.

10.3 Stains — This is a problem associated with bright-plated work. The most common cause is cleaner drying on the work during transfer. It can be eliminated by lowering the cleaner temperature, decreasing transfer time, installing fog nozzles to keep parts wet until they reach rinse tanks, or by using cleaners designed to prevent staining of sensitive nonferrous metals. It also can be caused by incomplete soil removal, particularly tightly adherent oils or a polar type almost impossible to remove in alkaline cleaners. Solvent degreasing or emulsifiable solvent predips may be required.

10.4 Roughness — This is caused by failure to remove smut or other solid particles. Sometimes this can be traced back to vapour degreasing which removes the oil but not the solid particles. If this is a cause, a high-pressure solvent spray will often help. Roughness also may be caused by incomplete rinsing of alkaline soak or electrocleaners due to excessive water hardness or an exhausted cleaner bath. Magnetically charged particles can cause roughness on plated steel parts.

NOTE — There are also a number of other reasons for these failures, not associated with cleaning.

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